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**Ishikawa**

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(54) **IMAGE FORMING APPARATUS HAVING A CHANGING SECTION FOR CHANGING THE WIDTH OF A TRANSFER SECTION**

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***G03G 15/16*** (2006.01)

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CPC ..... ***G03G 15/6558*** (2013.01); ***G03G 15/1605*** (2013.01); ***G03G 15/167*** (2013.01); *G03G 15/168* (2013.01); *G03G 2215/0154* (2013.01)

(58) **Field of Classification Search**
CPC ..... G03G 15/6558; G03G 15/605; G03G 15/167; G03G 2215/0154
USPC ..... 399/45, 66
See application file for complete search history.

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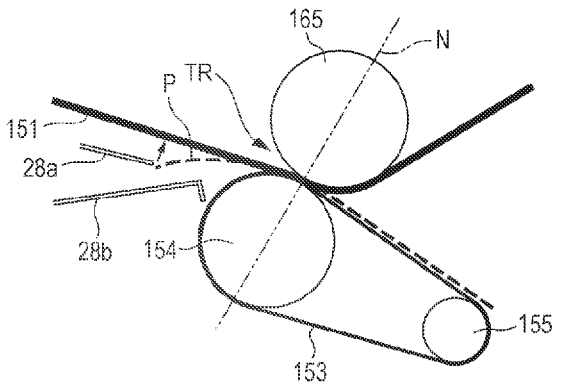
*Primary Examiner* — Clayton E LaBalle
*Assistant Examiner* — Trevor J Bervik
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An image forming apparatus includes an intermediate transfer belt that is stretched by multiple rollers, the intermediate transfer belt transporting a toner image on an outer peripheral surface, a second transfer member that performs second transfer, the second transfer transferring the toner image on the intermediate transfer belt to a recording medium, an opposed member that abuts against an inner peripheral surface of the intermediate transfer belt, the opposed member being opposed to the second transfer member, and a changing section that changes a width of contact between the intermediate transfer belt and the second transfer member at a second transfer position, on a basis of paper attribute information of the recording medium, the second transfer position being a position where the second transfer member abuts against the opposed member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

**13 Claims, 9 Drawing Sheets**



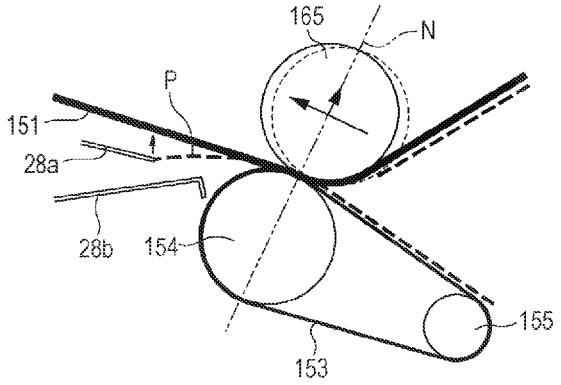



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FIG. 1

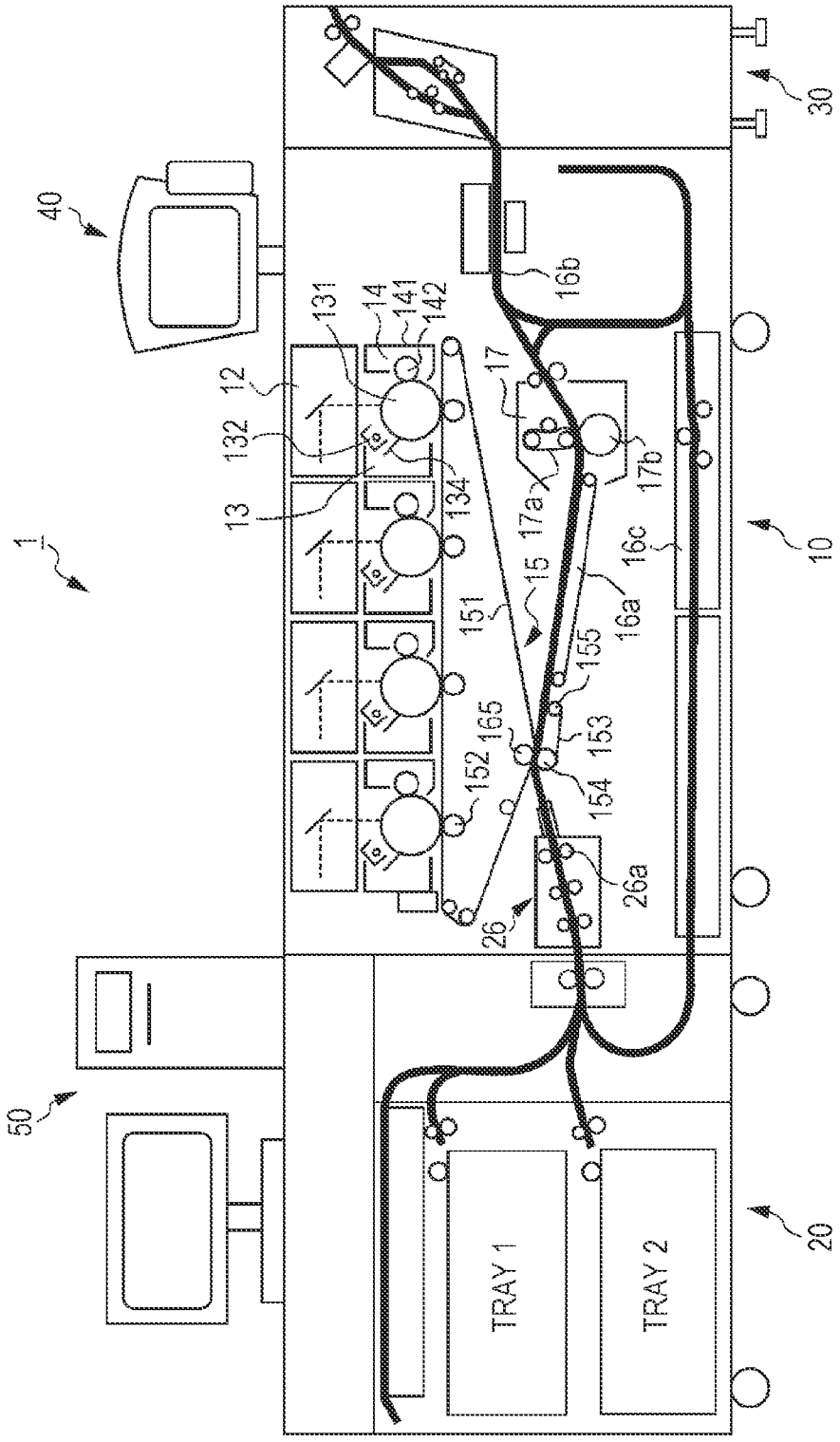

1
10
20
30
40
50
TRAY 1
TRAY 2
12
13
131
132
134
14
141
142
15
151
152
153
154
155
16a
16b
16c
17
17a
17b
165
26
26a
4a

FIG. 2

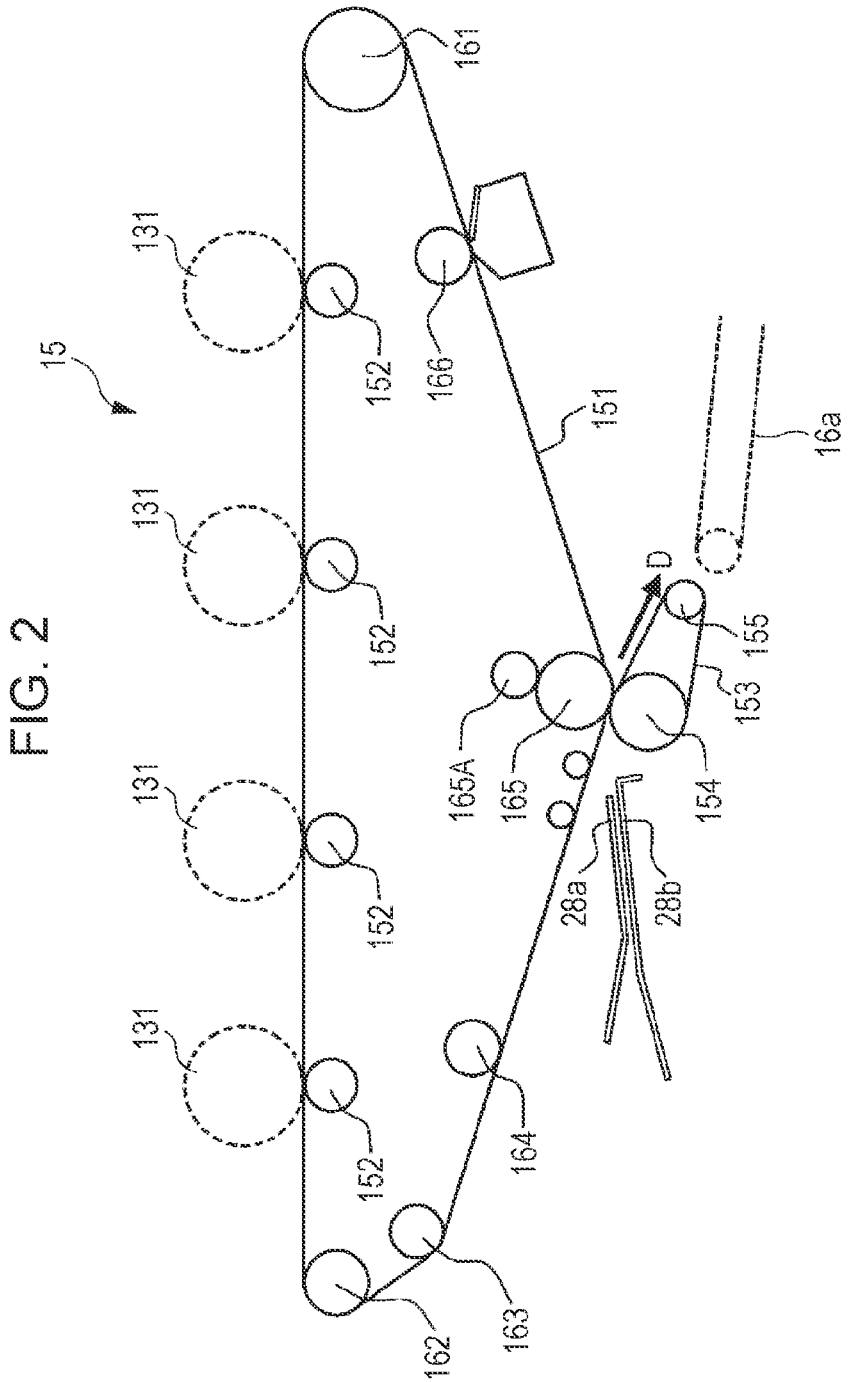

15
131
131
131
131
152
152
152
152
161
166
151
16a
D
155
153
154
165A
165
28a
28b
164
162
163

FIG. 3A

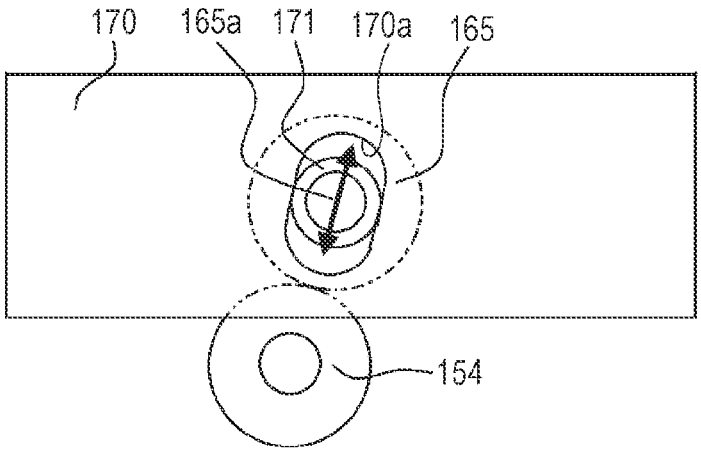

170
165a
171
170a
165
154

FIG. 3B

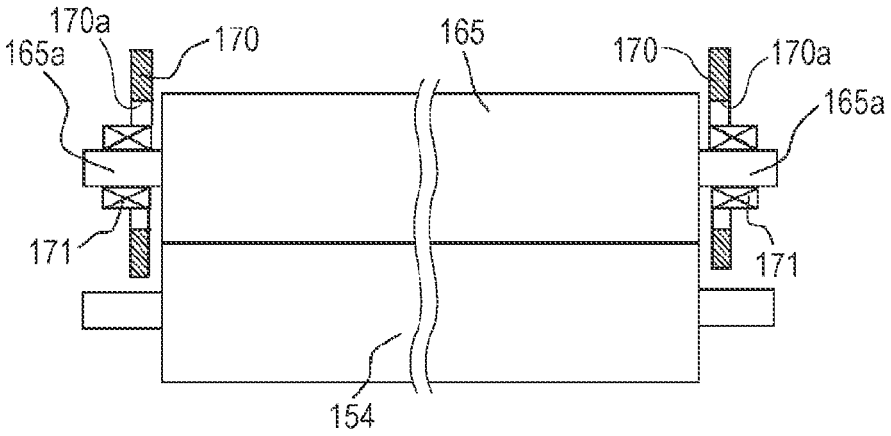

170a
165a
170
165
170
170a
165a
171
171
154

FIG. 4A

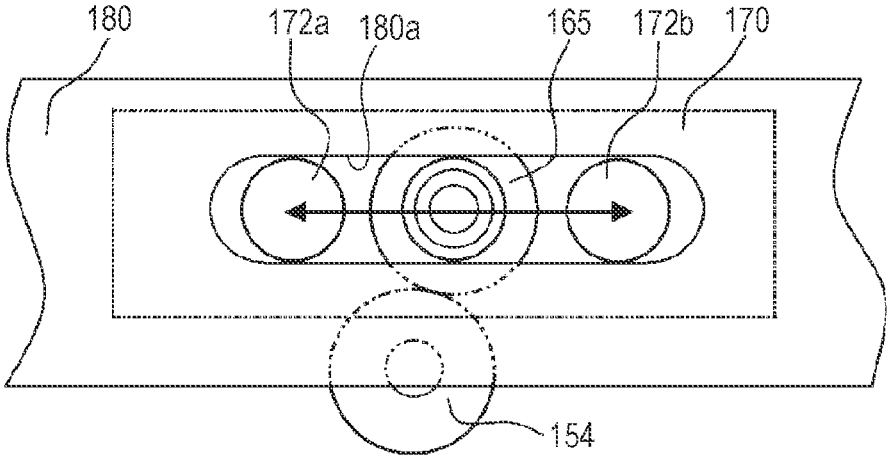



FIG. 4B

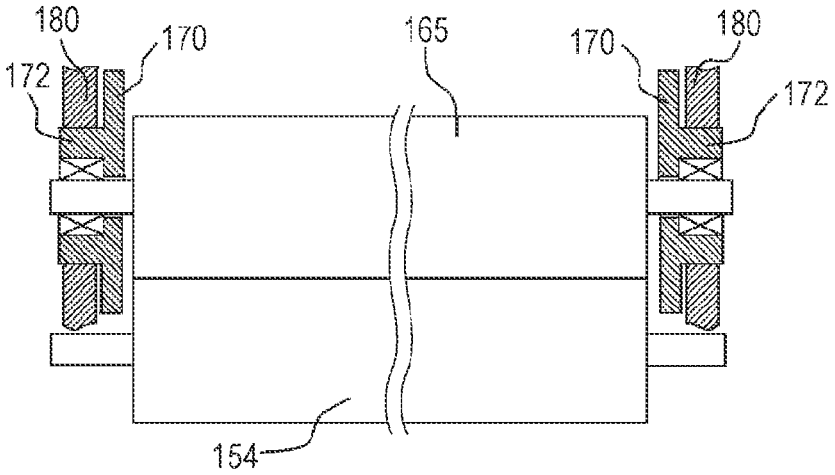


FIG. 5A

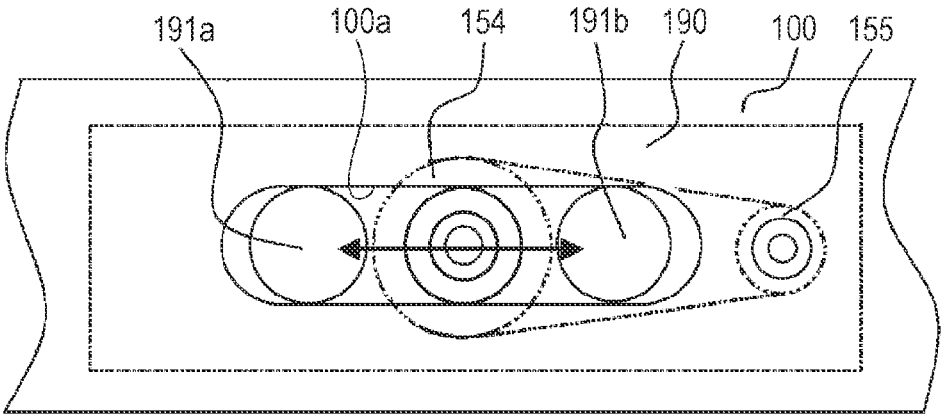



FIG. 5B

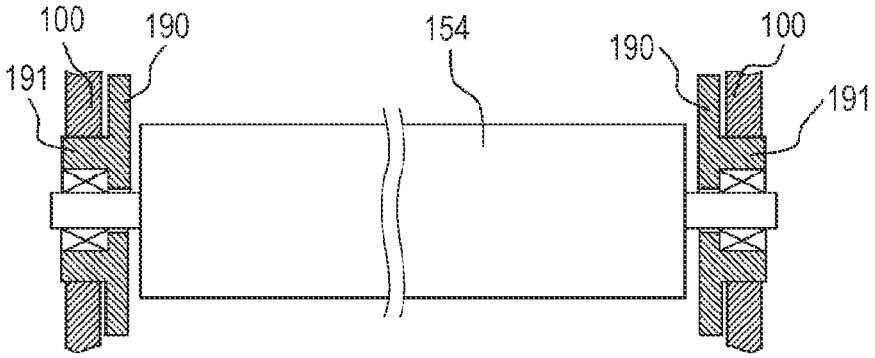
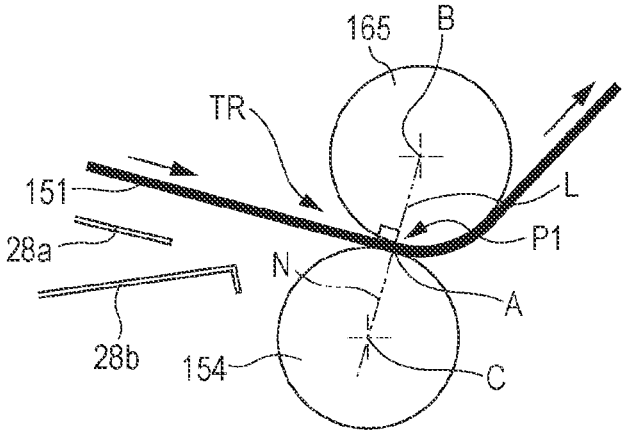
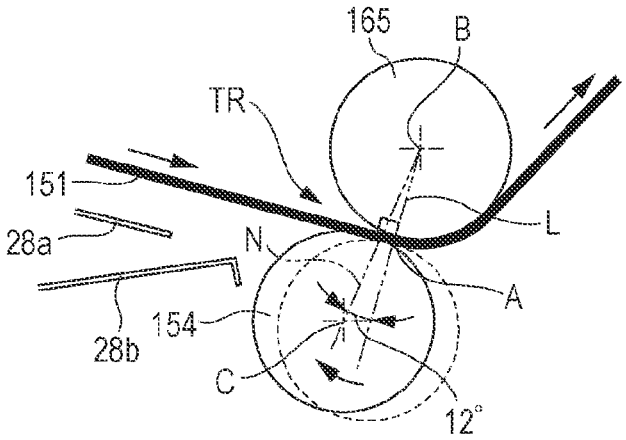


FIG. 6A




OFFSET ANGLE 0°

FIG. 6B




OFFSET ANGLE 12°

FIG. 7A

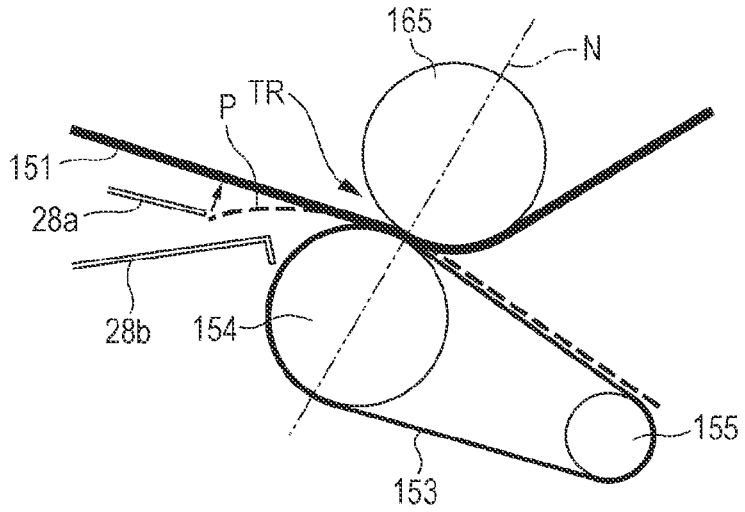



FIG. 7B

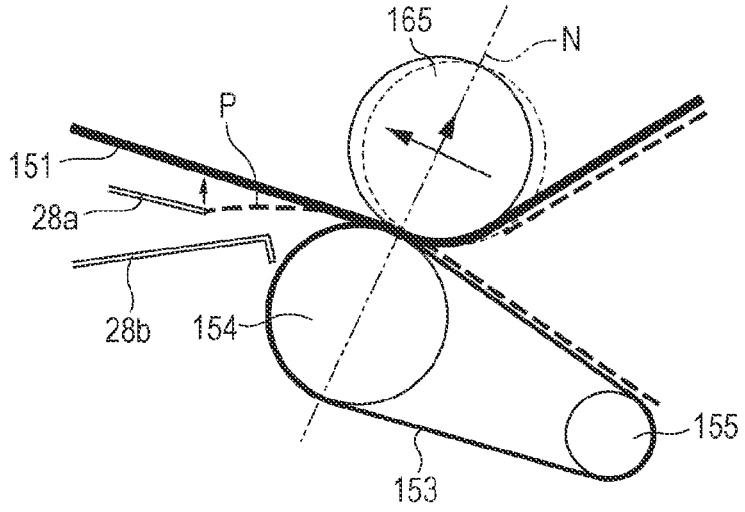


FIG. 8A

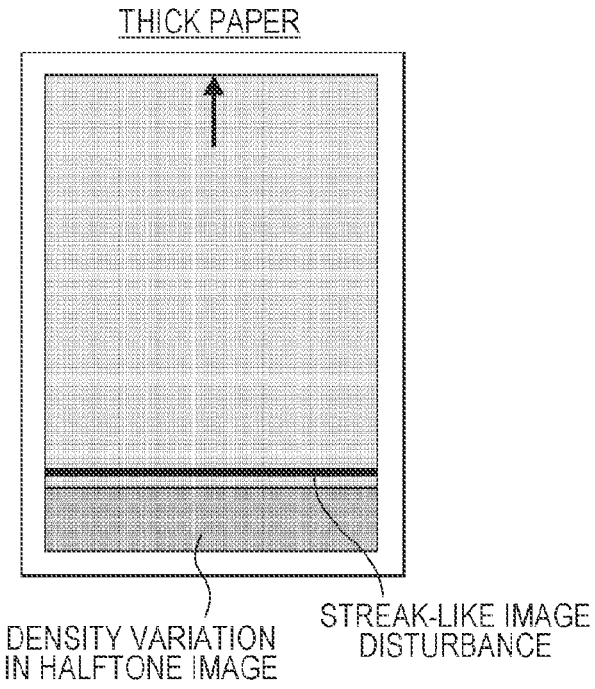



FIG. 8B

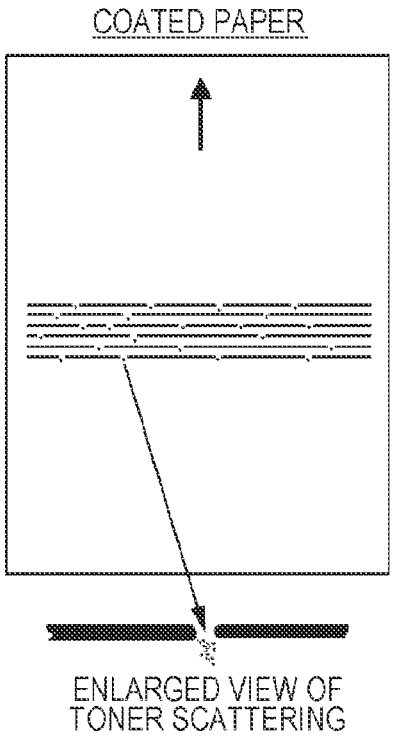



FIG. 9

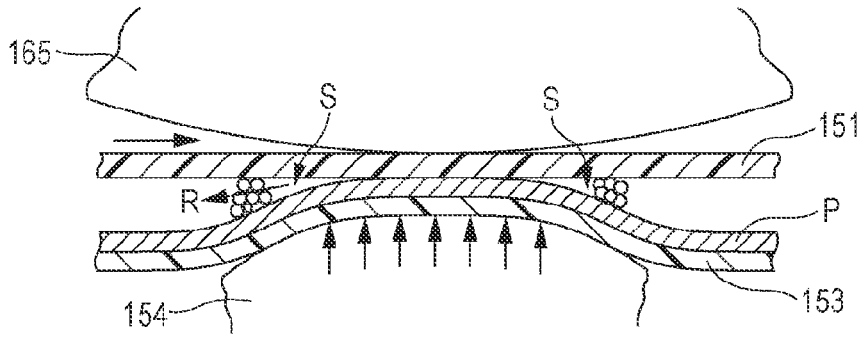
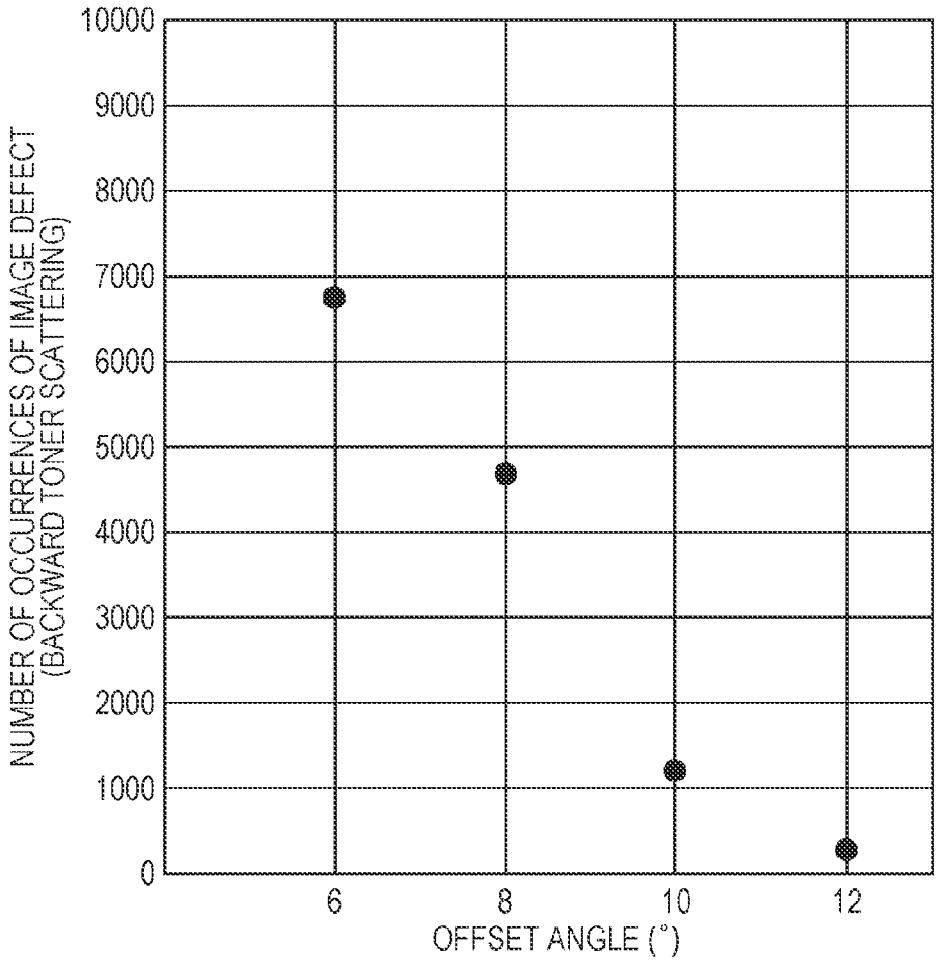


FIG. 10

| OFFSET ANGLE (°) | 6 | 8 | 10 | 12 |
|---|---|---|---|---|
| IMAGE DISTURBANCE EVALUATION GRADES | G1.5 | G2 | G3 | G4 |

FIG. 11



# IMAGE FORMING APPARATUS HAVING A CHANGING SECTION FOR CHANGING THE WIDTH OF A TRANSFER SECTION

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2013-003458 filed Jan. 11, 2013.

## BACKGROUND

### Technical Field

The present invention relates to an image forming apparatus.

## SUMMARY

According to an aspect of the invention, there is provided an image forming apparatus including an intermediate transfer belt that is stretched by multiple rollers, the intermediate transfer belt transporting a toner image on an outer peripheral surface, a second transfer member that performs second transfer, the second transfer transferring the toner image on the intermediate transfer belt to a recording medium, an opposed member that abuts against an inner peripheral surface of the intermediate transfer belt, the opposed member being opposed to the second transfer member, and a changing section that changes a width of contact between the intermediate transfer belt and the second transfer member at a second transfer position, on a basis of paper attribute information of the recording medium, the second transfer position being a position where the second transfer member abuts against the opposed member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

## BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a schematic cross-sectional view illustrating an example of a general configuration of an image forming apparatus;

FIG. **2** is a schematic cross-sectional view illustrating a configuration of a transfer device of the image forming apparatus;

FIGS. **3**A and **3**B are schematic diagrams each illustrating a configuration of a first moving mechanism of the transfer device;

FIGS. **4**A and **4**B are schematic diagrams each illustrating a configuration of a second moving mechanism of the transfer device;

FIGS. **5**A and **5**B are schematic diagrams each illustrating another configuration of the second moving mechanism of the transfer device;

FIGS. **6**A and **6**B are schematic cross-sectional views for explaining offset between a second transfer member and an opposed member at a second transfer position;

FIGS. **7**A and **7**B are schematic cross-sectional views of the major portion of the transfer device including a paper guide of the image forming apparatus;

FIGS. **8**A and **8**B are schematic diagrams each illustrating an example of the image defect to be addressed by an exemplary embodiment of the present invention;



FIG. **9** is a schematic diagram for explaining the probable cause of the image defect to be addressed by the exemplary embodiment of the present invention;

FIG. **10** illustrates the relationship between the offset position of a backup roller and a streak-like image disturbance that occurs in the image being transferred; and

FIG. **11** illustrates the relationship between the offset position of the backup roller and an image defect in which toner scatters backwards in the travelling direction.

## DETAILED DESCRIPTION

Next, the present invention will be described in further detail with reference to the figures, by way of its exemplary embodiment and specific examples. However, the present invention is not limited to the exemplary embodiment and specific examples.

It should be noted that in the following description made with reference to the figures, the figures are for illustrative purposes only, and the ratios among various dimensions and the like differ from the actuality. For the ease of understanding, components other than those required for explanation are not illustrated as appropriate.

(1) Overall Configuration and Operation of Image Forming Apparatus

(1.1) Overall Configuration of Image Forming Apparatus

FIG. **1** is a schematic cross-sectional view illustrating an example of a general configuration of an image forming apparatus **1** according to an exemplary embodiment of the present invention.

The image forming apparatus **1** includes an image forming unit **10**, a paper feed device **20** that is mounted to one end of the image forming unit **10**, a paper discharge unit **30** that is provided at the other end of the image forming unit **10** and from which printed paper is discharged, an operational information unit **40**, and an image processing unit **50** that generates image information from print information transmitted from a host apparatus.

The image forming unit **10** includes a system controller (not shown), an exposure device **12**, photoconductor units **13**, developing devices **14**, a transfer device **15**, paper transport devices **16***a*, **16***b*, and **16***c*, a fixing device **17**, and a driving device (not shown). The image forming unit **10** forms image information received from the image processing unit **50**, as a toner image on paper P fed from the paper feed device **20**.

The paper feed device **20** supplies paper to the image forming unit **10**. That is, the paper feed device **20** includes multiple paper loading units that receive different types (for example, material, thickness, paper size, and paper grain) of paper P. The paper feed device **20** supplies the paper P sent out from one of these multiple paper loading units to the image forming unit **10**.

The paper discharge unit **30** discharges the paper P to which an image has been outputted in the image forming unit **10**. For this reason, the paper discharge unit **30** has a discharge paper receiving unit to which the paper P that has undergone image output is discharged. The paper discharge unit **30** may have the function of performing post-processing such as cutting or stapling on a bundle of paper outputted from the image forming unit **10**.

The operational information unit **40** is used for inputting various settings and instructions, and displaying information. That is, the operational information unit **40** corresponds to a so-called user interface. Specifically, the operational information unit **40** is configured by a combination of a liquid crystal display panel, various operating buttons, a touch panel, and the like.

(1.2) Configuration and Operation of Image Forming Unit

In the image forming apparatus **1** configured as described above, in synchronism with the timing of image formation, each single sheet of the paper P to be printed by a print job sent out from a specified paper loading unit of the paper feed device **20** is fed to the image forming unit **10**.

The photoconductor units **13** are provided in parallel below the exposure device **12**. Each of the photoconductor units **13** includes a photoconductor drum **131**. The photoconductor drum **131** serves as an image carrier that is rotationally driven. A charger **132**, the exposure device **12**, the developing device **14**, a first transfer roller **152**, and a cleaning blade **134** are arranged along the rotational direction of the photoconductor drum **131**.

Each of the developing devices **14** has a developing housing **141** in which a developer is received. A developing roller **142** opposed to the photoconductor drum **131** is disposed inside the developing housing **141**. A layer regulating member (not illustrated) that regulates the layer thickness of developer is arranged in close proximity to the developing roller **142**.

The developing devices **14** are configured in substantially the same manner except for the developer received in the corresponding developing housing **141**. The developing devices **14** form toner images of yellow (Y), magenta (M), cyan (C), and black (B), respectively.

The surface of the photoconductor drum **131** that rotates is charged by the charger **132**. An electrostatic latent image is formed on the surface of the photoconductor drum **131** by latent image-forming light emitted from the exposure device **12**. The electrostatic latent image formed on the photoconductor drum **131** is developed as a toner image by the developing roller **142**.

The transfer device **15** includes an intermediate transfer belt **151**, the first transfer roller **152**, and a second transfer belt **153**. Toner images of various colors formed on the photoconductor drums **131** of the respective photoconductor units **13** are transferred to the intermediate transfer belt **151** in multiple layers. The first transfer roller **152** sequentially transfers the toner images of various colors formed in the photoconductor units **13** to the intermediate transfer belt **151** (first transfer). The second transfer belt **153** transfers the toner images of various colors that have been transferred onto the intermediate transfer belt **151** in a superimposed manner, to the paper as a recording medium at once (second transfer).

The second transfer belt **153** is stretched by the second transfer roller **154** and a peeling roller **155**. The second transfer belt **153** is sandwiched between a backup roller **165** arranged on the back side of the intermediate transfer belt **151**, and the second transfer roller **154**, thus forming a second transfer part (TR).

The toner images of various colors formed on the photoconductor drums **131** of the respective photoconductor units **13** are electrostatically transferred onto the intermediate transfer belt **151** sequentially (first transfer) by the first transfer roller **152** to which a predetermined transfer voltage is applied from a power supply device (not illustrated) controlled by the system controller, thereby forming superimposed toner images on which various colors of toner are superimposed.

As the intermediate transfer belt **151** moves, the superimposed toner images on the intermediate transfer belt **151** are transported to a region (second transfer part TR) where the second transfer belt **153** is arranged. Once the superimposed toner images are transported to the second transfer part TR, the paper P is supplied to the second transfer part TR from the paper feed device **20** in synchronism with this timing. Then, a predetermined transfer voltage is applied to the backup roller **165** that is opposed to the second transfer roller **154** with the second transfer belt **153** therebetween, from the power supply device or the like controlled by the system controller, and the multilayer toner images on the intermediate transfer belt **151** are transferred onto the paper P at once.

Residual toner on the surface of the photoconductor drum **131** is removed by the cleaning blade **134**, and recovered to a waste toner receiving unit (not illustrated). The surface of the photoconductor drum **131** is charged by the charger **132** again.

The fixing device **17** includes an endless fixing belt **17***a* that rotates in one direction, and a pressure roller **17***b* that contacts the peripheral surface of the fixing belt **17***a* and rotates in one direction. A nip part (fixing region) is formed by the press contact region between the fixing belt **17***a* and the pressure roller **17***b*.

The paper P with the toner image transferred in the transfer device **15** is transported to the fixing device **17** via the paper transport device **16***a* in a state in which the toner image has not been fixed yet. The toner image is fixed onto the paper P transported to the fixing device **17** with pressure and heat applied by the pair of the fixing belt **17***a* and the pressure roller **17***b*.

The paper P with the fixed toner image is fed to the paper discharge unit **30** via the paper transport device **16***b*.

In the case of outputting an image onto both sides of the paper P, the front and back sides of the paper P are reversed by the paper transport device **16***c*, and the paper P is fed to the second transfer part TR of the image forming unit **10** again. Then, after a toner image is transferred and the transferred image is fixed onto the paper P, the paper P is fed to the paper discharge unit **30**. The paper P fed to the paper discharge unit **30** undergoes post-processing such as cutting or stapling as required, before being discharged to the discharge paper receiving unit.

(2) Configuration and Action of Transfer Device

(2.1) Configuration of Transfer Device

FIG. **2** is a schematic cross-sectional view illustrating a configuration of the transfer device **15** of the image forming apparatus **1** according to the exemplary embodiment.

The transfer device **15** includes the intermediate transfer belt **151**, the first transfer roller **152**, and the second transfer belt **153**.

The intermediate transfer belt **151** used is made of resin such as polyimide or polyamide containing a suitable amount of conductive agent such as carbon black, and has a volume resistivity of $10^6$ to $10^{14}$ Ω·cm. The intermediate transfer belt **151** is formed as an endless belt in a film-like form with a thickness of, for example, about 0.1 mm.

The intermediate transfer belt **151** has a driving roller **161**, a driven roller **162**, a tension roller **163**, a support roller **164**, the backup roller **165**, and a cleaning backup roller **166**. The driving roller **161** drives the intermediate transfer belt **151** so as to circulate. The driven roller **162** supports the intermediate transfer belt **151** that extends in a substantially straight line along the arrangement direction of the photoconductor drums **131**. The tension roller **163** applies a predetermined tension to the intermediate transfer belt **151** and prevents meandering of the intermediate transfer belt **151**. The support roller **164** is provided on the upstream side of the second transfer part TR, and supports the intermediate transfer belt **151**. The backup roller **165** is provided in the second transfer part TR. The cleaning backup roller **166** is provided in a cleaning part that scrapes off residual toner on the intermediate transfer belt **151**.

The backup roller **165** is a blended rubber tube of EPDM and NBR with carbons dispersed on its surface. The inside of the backup roller **165** is made of EPDM rubber. The backup roller **165** has a surface resistivity of $10^7$ to $10^{10}$ Ω/sq and a roller diameter of 28 mm. The hardness of the backup roller **165** is set to, for example, 70 degrees (Asker-C).

The backup roller **165** is arranged on the back side of the intermediate transfer belt **151**, and forms a counter electrode for the second transfer belt **153**. A power supply roller **165**A made of metal is arranged in contact with the backup roller **165**. The power supply roller **165**A applies a bias voltage for forming a second transfer electric field in the second transfer part TR.

The first transfer roller **152** is opposed to each of the photoconductor drums **131** with the intermediate transfer belt **151** therebetween. The first transfer roller **152** is applied with a voltage of a polarity opposite to the polarity in which toner is charged. Consequently, toner images on the photoconductor drums **131** are electrostatically attracted to the intermediate transfer belt **151** sequentially, thereby forming superimposed toner images on the intermediate transfer belt **151**.

The second transfer belt **153** is a semi-conductive endless annular belt that is made of resin such as polyimide or polyamide containing a suitable amount of conductive agent such as carbon black, and whose volume resistivity is adjusted to, for example, $10^6$ to $10^{10}$ Ω·cm. As illustrated in FIG. **2**, the second transfer belt **153** is stretched by the second transfer roller **154** and the peeling roller **155**, and is applied with a predetermined tension in advance. Further, in the exemplary embodiment, the second transfer belt **153** receives a driving force from the second transfer roller **154**, and rotates in the direction of an arrow D in FIG. **2** at a predetermined speed.

The second transfer roller **154** is made of semi-conductive rubber with a volume resistivity of, for example, $10^6$ to $10^{10}$ Ω·cm. The second transfer roller **154** is opposed to the backup roller **165** with the second transfer belt **153** and the intermediate transfer belt **151** therebetween. The second transfer roller **154** forms the second transfer part TR together with the backup roller **165** where a toner image carried by the intermediate transfer belt **151** is transferred (second transfer) to the paper P being transported on the second transfer belt **153**.

Further, a driving motor (not illustrated) is connected to the second transfer roller **154**. As the second transfer roller **154** receives a rotational drive force from the driving motor, the second transfer roller **154** rotates, and further causes the second transfer belt **153** to rotate.

The second transfer roller **154** is fixed in position by a second transfer belt holding member **190**. The backup roller **165** is rotatably supported by a bearing **171** provided to a backup roller holding member **170**.

The backup roller **165** is urged by a moving mechanism described later toward the second transfer roller **154** via the second transfer belt **153**, in a constant displacement state according to the basis weight of the paper P. A nip part is formed over a predetermined width between the second transfer roller **154** and the backup roller **165**.

As illustrated in FIG. **2**, the peeling roller **155** is located on the downstream side of the second transfer roller **154** with respect to the rotational direction (direction of the arrow D in FIG. **2**) of the second transfer belt **153**. The peeling roller **155** and the second transfer roller **154** form a belt surface for transporting the paper P to the downstream side.

Further, in order to peel the paper P from the surface of the second transfer belt **153**, the roller diameter of the peeling roller **155** is set to less than or equal to half the roller diameter of the second transfer roller **154**.

A paper guide **28** is arranged on the upstream side of the second transfer part TR of the transfer device **15**. The paper guide **28** is opposed to the toner image-carrying surface of the intermediate transfer belt **151**, and guides the paper P to the second transfer part TR.

The paper guide **28** includes a paper guide **28***a* that guides the upper surface (transfer surface) of the paper P, and a paper guide **28***b* that guides the lower surface (non-transfer surface) of the paper P.

(2.2) Configuration of Moving Mechanisms

FIGS. **3**A and **3**B are schematic diagrams each illustrating a configuration of a first moving mechanism that supports the backup roller **165** in a manner that allows the backup roller **165** to move so as to come into abutment with the second transfer roller **154**. FIGS. **4**A and **4**B are schematic diagrams each illustrating a configuration of a second moving mechanism that supports the backup roller **165** in a manner that allows the backup roller **165** to move along a paper transport direction (direction that intersects the normal N to the transfer nip (hereinafter simply referred to as "transfer nip normal N"). FIGS. **5**A and **5**B are schematic diagrams each illustrating another configuration of the second moving mechanism that supports the second transfer roller **154** and the second transfer belt **153** in a manner that allows the second transfer roller **154** and the second transfer belt **153** to move along the paper transport direction (direction that intersects the transfer nip normal N). Hereinafter, the moving mechanisms for the backup roller **165** will be described with reference to FIGS. **3**A to **5**B.

As illustrated in FIGS. **3**A and **3**B, the backup roller **165** is attached to the backup roller holding member **170**. A rotating shaft **165***a* is provided at either end portion in the axial direction (direction that intersects the paper transport direction) of the backup roller **165**. The rotating shaft **165***a* is rotatably supported on the bearing **171** that is provided inside the backup roller holding member **170**.

The bearing **171** is slidably supported in an elongated hole **170***a*. The elongated hole **170***a* is formed so as to penetrate either side wall portion of the backup roller holding member **170**. As a first eccentric cam plate (not illustrated) is rotationally driven by the driving motor (not illustrated), the bearing **171** moves in the direction of the longitudinal diameter axis of the elongated hole **170***a*. The longitudinal diameter of the elongated hole **170***a* is in the same direction as the imaginary transfer nip normal N drawn connecting the center B of the backup roller **165** and the center C of the second transfer roller **154** at the second transfer position.

That is, the backup roller **165** is movable inside the backup roller holding member **170** so as to come into abutment with the second transfer roller **154**.

Further, as illustrated in FIGS. **4**A and **4**B, two support shafts **172** (**172***a* and **172***b*) protrude from the outer end faces of opposite side wall portions of the backup roller holding member **170**. The support shafts **172** are disposed so as to penetrate a transfer device frame **180** that supports the transfer device **15**. In order to allow penetration of the support shafts **172**, the transfer device frame **180** has an elongated hole **180***a* that is formed along the paper transport direction (direction that intersects the transfer nip normal N).

As a second eccentric cam plate (not illustrated) is rotationally driven by the driving motor (not illustrated), the backup roller holding member **170** moves in the direction of the longitudinal diameter of the elongated hole **180***a*.

According to this configuration, at the second transfer position, the backup roller **165** supported by the backup roller holding member **170** is able to move in the direction of the transfer nip normal N via the intermediate transfer belt **151**,

thereby making it possible to vary the amount of abutment (amount of bite) with the second transfer roller **154** and the second transfer belt **153**.

Further, an offset can be made along the paper transport direction (direction that intersects the transfer nip normal N), which makes it possible to vary the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153** at the second transfer position.

In the exemplary embodiment, an offset means moving the transfer nip normal N formed by the backup roller **165** and the second transfer roller **154**, with respect to an imaginary line L connecting the center B of the backup roller **165** and a point A at which the intermediate transfer belt **151** begins its contact with the peripheral surface of the backup roller **165**, with the center B of the backup roller **165** as a starting point.

The angle ∠ABC formed by the imaginary line L and the transfer nip normal N is defined as offset angle. Offsetting the second transfer roller **154** to the upstream side of the paper transport direction makes it possible to vary the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153** (see FIG. **6**B).

As illustrated in FIGS. **5**A and **5**B, the second transfer roller **154** and the peeling roller **155** are secured to the second transfer belt holding member **190**, with the second transfer belt **153** being stretched by the second transfer roller **154** and the peeling roller **155**.

Two support shafts **191** (**191***a* and **191***b*) protrude from the outer end faces of opposite side wall portions of the second transfer belt holding member **190**. The support shafts **191** are disposed so as to penetrate a frame **100** provided to the body of the image forming apparatus **1**.

In order to allow penetration of the support shafts **191**, the frame **100** has an elongated hole **100***a* that is formed along the paper transport direction (direction that intersects the transfer nip normal N). The longitudinal diameter of the elongated hole **100***a* is in the same direction as the paper transport direction (direction that intersects the transfer nip normal N).

As a third eccentric cam plate (not illustrated) is rotationally driven by the driving motor (not illustrated), the second transfer belt holding member **190** moves in the direction of the longitudinal diameter of the elongated hole **100***a*.

According to this configuration, the second transfer roller **154** and the second transfer belt **153** that are supported by the second transfer belt holding member **190** are able to move in the paper transport direction (direction that intersects the transfer nip normal N), which makes it possible to vary the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153** at the second transfer position.

(2.3) Action of Transfer Device

FIGS. **7**A and **7**B are schematic cross-sectional views of the major portion of the transfer device **15** including the paper guide **28** of the image forming apparatus **1** configured as mentioned above. Hereinafter, the action of the transfer device **15** will be described with reference to FIGS. **7**A and **7**B.

A toner image formed on the photoconductor drum **131** of each of the photoconductor units **13** is transferred onto the intermediate transfer belt **151** in a first transfer part where each of the photoconductor drums **131** and the intermediate transfer belt **151** are opposed to each other. The unfixed toner image that has undergone the first transfer is transported to the second transfer part TR as the intermediate transfer belt **151** rotates.

The paper feed device **20** supplies the paper P of a predetermined size in synchronism with the timing of image formation. The paper P supplied by the paper feed device **20** reaches the second transfer part TR via an orientation correcting unit **26**. The paper P is temporarily stopped, and registration rollers **26***a* are rotated in synchronism with the movement timing of the intermediate transfer belt **151** carrying the toner image, thereby performing registration between the paper P and the toner image.

Then, the paper P transported in a synchronized manner is nipped in the second transfer part TR between the intermediate transfer belt **151** and the second transfer belt **153**. The power supply roller **165**A forms a transfer electric field by applying a voltage of the same polarity as the polarity in which toner is charged. The transfer electric field thus formed causes the unfixed toner image carried on the intermediate transfer belt **151** to be electrostatically transferred to the paper P, in the second transfer part TR formed by the second transfer roller **154** and the backup roller **165**.

Thereafter, the paper P with the electrostatically transferred toner image is transported to the downstream side by the second transfer belt **153**, and upon reaching the position of the peeling roller **155**, the paper P is peeled from the second transfer belt **153**.

Then, the paper P is transported by the paper transport device **16***a* that is provided on the downstream side of the transport direction. The paper transport device **16***a* transports the paper P to the fixing device **17** at a speed suited to a fixing process in the fixing device **17**. The fixing device **17** performs a fixing process by application of heat and pressure, thereby fixing the unfixed toner image on the paper P onto the paper P. Then, the paper P with the fixed image is discharged to the paper discharge unit **30** by the paper transport device **16***a*. Residual toner that remains on the intermediate transfer belt **151** after transfer of the image to the paper P is finished is removed by a belt cleaner.

In the image forming apparatus **1**, not only general copy papers but various papers are used. For applications aimed at vendors such as publishing and advertising services, toner images are formed on a wide variety of papers such as wood-free paper, wood-containing paper, coated paper, and art paper.

In particular, in a case where a piece of thick paper with a basis weight of 300 g/m$^2$ to 450 g/m$^2$ is used as the paper P, or in a case where a piece of coated paper to which surface coating has been applied to improve smoothness is used as the paper P, an image disturbance can occur owing to the characteristics of the respective papers.

(2.3.1) Thick Paper

In a case where a piece of thick paper with a basis weight of 300 g/m$^2$ to 450 g/m$^2$ is used as the paper P, when the trailing edge of the paper P passes the distal end of the paper guide **28***a* and is released from constraint, and comes into contact with the outer peripheral surface of the intermediate transfer belt **151**, a streak-like image disturbance may occur in the image being transferred in the second transfer part TR in some cases (see FIG. **8**A).

When the trailing edge of the paper P passes the distal end of the paper guide **28***a* that guides the upper surface (transfer surface) of the paper P, a force is applied to the paper P in the direction of the transfer nip normal N which connects the center of the backup roller **165** and the center of the second transfer roller **154** (see FIG. **7**A). In a case where the paper used is a piece of thick paper and thus has increased stiffness, the force acting in the direction of the transfer nip normal becomes an impact force when the trailing edge collides against the surface of the intermediate transfer belt **151**, caus-

ing the intermediate transfer belt **151** to vibrate so as to be displaced at right angles to the peripheral surface. It is assumed that such vibration is transmitted to a transfer position P**1**, causing a streak-like image disturbance to occur in the image being transferred.

As the intermediate transfer belt **151** and the paper P vibrate owing to this impact force, a minute gap formed between the surfaces of the intermediate transfer belt **151** and second transfer belt **153** in a region located upstream of a region where the second transfer roller **154** and the backup roller **165** are strongly pressed against each other at the transfer position P**1** changes, with the result that the second transfer electric field becomes unstable, causing an image disturbance (density variation in a halftone image or the like) in the trailing edge portion of the paper in some cases (see FIG. **8**A).

In the image forming apparatus **1** according to the exemplary embodiment, on the basis of the basis weight of the paper P as paper attribute information (such as the material, thickness, size, and paper grain of the paper), the system controller varies the amount of bite by causing the first moving mechanism to press or separate the backup roller **165** against or from the second transfer roller **154** in the direction of the transfer nip normal N. Then, the system controller causes the second moving mechanism to offset the backup roller **165** in the paper transfer direction (direction that intersects the transfer nip normal N), thereby varying the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153**.

Specifically, in a case where the paper P is a piece of thick paper, the amount of bite in the direction of the transfer nip normal N at the second transfer position is reduced. In addition, the backup roller **165** is offset to the upstream side of the paper transport direction (direction that intersects the transfer nip normal), thereby reducing the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153** (see FIG. **7**B).

Owing to this change, the force that acts in the direction of the transfer nip normal when the trailing edge of the paper P passes the distal end of the paper guide **28***a* decreases. As a result, the impact force exerted when the trailing edge collides against the surface of the intermediate transfer belt **151** decreases, thereby reducing a streak-like image disturbance that occurs in the image being transferred.

Experiment 1

Image formation is performed under the following conditions by the image forming apparatus **1** according to the exemplary embodiment, and an effect checking test is conducted by evaluating a streak-like image disturbance that occurs in the image being transferred by comparison against a comparative example. The results of the test will be described below.

With the case illustrated in FIG. **6**B where the offset angle is 12° taken as the comparative example, image formation is performed while changing the offset angle.

(Test Conditions)

Print speed: 440 mm/s

Paper basis weight: 300 g/m$^2$

External environment temperature: 22° C./55% RH

(Evaluation Criteria for Streak-like Image Disturbance)

G0: None

G1: Slight

G2: Visible

G3: Clearly visible

G4: Dark and long

As the image for evaluation, the halftone image pattern illustrated in FIG. **8**A is used.

In the image forming apparatus **1** according to the exemplary embodiment, the amount of bite of the backup roller **165** is reduced from 0.9 mm to 0.3 mm by the first moving mechanism that serves as a changing section that changes the contact position of the backup roller **165** with the intermediate transfer belt **151** at the second transfer position TR, and the backup roller **165** is offset by the second moving mechanism to the upstream side of the paper transport direction (direction that intersects the transfer nip normal N) at offset angles of 10°, 8°, and 6°, as opposed to the offset angle of the comparative example (12°), thereby reducing the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153**.

As illustrated in FIG. **10**, at the offset angle of the comparative example (12°), a dark and long streak-like image disturbance (G4) occurs.

As the offset angle of the backup roller **165** is decreased to 10°, 8°, and then 6°, the level of the streak-like image disturbance improves to G3, G2, and then G1.5 (intermediate state between G1 and G2), respectively.

It is appreciated from the above discussion that the impact force exerted when the trailing edge of the paper P passes the distal end of the paper guide **28***a* and collides against the surface of the intermediate transfer belt **151** is mitigated, thereby reducing a streak-like image disturbance that tends to occur in the image being transferred at the second transfer position TR.

(2.3.2) Coated Paper

In a case where the paper P used is a piece of coated paper to which surface coating has been applied to improve smoothness, the following image defect occurs in some cases. That is, toner scatters backwards in the travelling direction of the paper P immediately before entering the region where the second transfer roller **154** and the backup roller **165** are strongly pressed against each other at the second transfer position TR (see FIG. **8**B). Such an image defect tends to occur in a case where the toner image to be formed includes multiple thin lines running at right angles to the travelling direction of the paper P.

On the upstream side of the region where the second transfer roller **154** and the backup roller **165** are strongly pressed against each other, the intermediate transfer belt **151** and the paper P are laid over each other as illustrated in FIG. **9**, and the back surface of the paper P comes into contact with the intermediate transfer belt **151**. At this time, toner on the intermediate transfer belt **151** becomes lodged in between the intermediate transfer belt **151** and the paper P, and a space S is formed between thin lines of toner located on the forward side and thin lines of toner located on the backward side.

When the paper P enters the region where the second transfer roller **154** and the backup roller **165** are strongly pressed against each other at the second transfer position, this space S is crushed from the forward side by a large press contact force exerted at this time. In the case of an image including multiple thin lines running at right angles to the travelling direction of the paper P, for example, the air within the space S becomes confined, making it difficult for a discharge path for the air to form.

Consequently, when the space S is crushed from the forward side, as indicated by an arrow R in FIG. **9**, a group of toner particles forming thin lines on the backward side where the press contact force is weak is blown away by the air pressure, and thus the air within the space S is released to the backward side. It is assumed that toner forming thin lines on the backward side is thus scattered backwards.

In the image forming apparatus **1** according to the exemplary embodiment, in accordance with the paper material as

paper attribute information, the system controller causes the second moving mechanism to offset the backup roller **165** along the paper transport direction (direction that intersects the transfer nip normal N), thereby varying the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153**.

Specifically, in a case where the paper P is a piece of coated paper, the backup roller **165** is moved to the downstream side of the paper transport direction (direction that intersects the transfer nip normal N), thereby increasing the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153**.

As a result, a force that constrains toner lodged in between the intermediate transfer belt **151** and the paper P is generated in a transfer pre-nip part, thereby keeping toner from scattering backwards in the travelling direction immediately before entering the region where the second transfer roller **154** and the backup roller **165** are strongly pressed against each other.

When offsetting the backup roller **165** to the downstream side, if the backup roller **165** is offset in such a way as to decrease the pressing force between the second transfer roller **154** and the backup roller **165**, less compressive force is exerted on the space S formed between thin lines of toner located on the forward side and thin lines of toner located on the backward side, thereby more effectively reducing the occurrence of an image defect in which toner scatters backwards in the travelling direction immediately entering the second transfer position.

Experiment 2

Image formation is performed under the following conditions by the image forming apparatus **1** according to the exemplary embodiment. The relationship between the frequency of occurrence of an image defect in which toner scatters backwards, and the amount of offset by which the backup roller **165** is moved along the paper transport direction (direction that intersects the transfer nip normal N) in this case will be described.

(Test Conditions)

Print speed: 440 mm/sec

Paper basis weight: 127 $g/m^2$

Paper type: coated paper

External environment temperature: 22° C./55% RH

Image: monochrome image with a line width of 0.3 mm and a thin line pitch of 2.5 mm

As an image typically prone to an image defect in which toner scatters backwards, a monochrome image with a line width of 0.3 mm and a thin line pitch of 2.5 mm is formed on the intermediate transfer belt **151**, and after being transferred onto the paper P at the second transfer position, the monochrome image is fixed onto the paper P. Then, the number of locations where a defect in which toner scatters backwards has occurred is counted, and the counted value is used as an evaluation characteristic value. The counting is performed by reading the image forming surface of the paper P with an image reading device according to related art.

FIG. **11** illustrates, as relative values, the numbers of occurrences of an image defect when the backup roller **165** is moved along the paper transport direction (direction that intersects the transfer nip normal N) to vary the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153**.

As illustrated in FIG. **11**, as the width of contact between the intermediate transfer belt **151**, the second transfer roller **154**, and the second transfer belt **153** is increased by offsetting the backup roller **165** at offset angles of 6°, 8°, 10°, and then 12° to the downstream side of the paper transport direction (direction that intersects the transfer nip normal N), the number of occurrences of an image defect is reduced.

While each of the first moving mechanism and the second moving mechanism moves the backup roller **165** in Experiment 1 and Experiment 2 mentioned above, each of the first moving mechanism and the second moving mechanism may move the second transfer roller **154**.

While the exemplary embodiment of the present invention has been described in detail above, the present invention is not limited to the exemplary embodiment mentioned above but various modifications are possible within the scope of the present invention as defined by the claims.

For example, while the image forming apparatus **1** according to the exemplary embodiment has been described as a tandem color printer using an intermediate transfer belt which employs a second transfer belt system, the present invention is also applicable to an image forming apparatus employing a second transfer roller system which does not have a second transfer belt.

What is claimed is:

**1**. An image forming apparatus comprising:

an intermediate transfer belt that is stretched by a plurality of rollers, the intermediate transfer belt transporting a toner image on an outer peripheral surface;

a second transfer member that performs second transfer, the second transfer transferring the toner image on the intermediate transfer belt to a recording medium;

an opposed member that abuts against an inner peripheral surface of the intermediate transfer belt, the opposed member being opposed to the second transfer member; and

a changing section that changes a contact length between the intermediate transfer belt and the second transfer member at a second transfer position by changing a position of the opposed member, on a basis of paper attribute information of the recording medium, the second transfer position being a position where the second transfer member abuts against the opposed member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member,

wherein the opposed member is in contact with the second transfer member via the intermediate transfer belt.

**2**. The image forming apparatus according to claim **1**, wherein when the paper attribute information indicates that the recording medium is a recording medium having a thickness greater than or equal to a predetermined thickness, the changing section changes the contact length between the intermediate transfer belt and the second transfer member so as to decrease.

**3**. The image forming apparatus according to claim **2**, wherein when the paper attribute information indicates that the recording medium is a recording medium having a thickness greater than or equal to a predetermined thickness, the changing section further changes a pressing force so as to decrease, the pressing force being generated between the second transfer member and the opposed member opposed to the second transfer member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

**4**. The image forming apparatus according to claim **1**, wherein when the paper attribute information indicates that the recording medium is a recording medium having a thickness less than or equal to a predetermined thickness, the changing section changes the contact length between the intermediate transfer belt and the second transfer member so as to increase.

5. The image forming apparatus according to claim 4, wherein when the paper attribute information indicates that the recording medium is a recording medium having a thickness less than or equal to a predetermined thickness, the changing section further changes a pressing force so as to increase, the pressing force being generated between the second transfer member and the opposed member opposed to the second transfer member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

6. The image forming apparatus according to claim 1, wherein when the paper attribute information indicates that the recording medium is a recording medium whose recording surface has a coating layer, the changing section changes the contact length between the intermediate transfer belt and the second transfer member so as to increase.

7. The image forming apparatus according to claim 6, wherein when the paper attribute information indicates that the recording medium is a recording medium whose recording surface has a coating layer, the changing section further changes a pressing force so as to decrease, the pressing force being generated between the second transfer member and the opposed member opposed to the second transfer member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

8. The image forming apparatus according to claim 1, wherein when the paper attribute information indicates that the recording medium is a recording medium having a basis weight greater than or equal to a predetermined basis weight, the changing section changes the contact length between the intermediate transfer belt and the second transfer member so as to decrease.

9. The image forming apparatus according to claim 8, wherein when the paper attribute information indicates that the recording medium is a recording medium having a basis weight greater than or equal to a predetermined basis weight, the changing section further changes a pressing force so as to decrease, the pressing force being generated between the second transfer member and the opposed member opposed to the second transfer member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

10. The image forming apparatus according to claim 1, wherein when the paper attribute information indicates that the recording medium is a recording medium having a basis weight less than or equal to a predetermined basis weight, the changing section changes the contact length between the intermediate transfer belt and the second transfer member so as to increase.

11. The image forming apparatus according to claim 10, wherein when the paper attribute information indicates that the recording medium is a recording medium having a basis weight less than or equal to a predetermined basis weight, the changing section further changes a pressing force so as to increase, the pressing force being generated between the second transfer member and the opposed member opposed to the second transfer member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member.

12. An image forming apparatus comprising:

an intermediate transfer belt that is stretched by a plurality of rollers, the intermediate transfer belt transporting a toner image on an outer peripheral surface;

a second transfer belt that performs second transfer, the second transfer transferring the toner image on the intermediate transfer belt to a recording medium, the second transfer belt stretched by the second transfer roller and another member, the second transfer roller having a second wrapped area where the second transfer belt wraps a surface of the second transfer roller;

an opposed member that abuts against an inner peripheral surface of the intermediate transfer belt, the opposed member being opposed to the second transfer belt; and

a changing section that changes contact length between the intermediate transfer belt and the second transfer member at a second transfer position by changing a position of the opposed member so as to change the second wrapped area, on a basis of paper attribute information of the recording medium, the second transfer position being a position where the second transfer member abuts against the opposed member with the intermediate transfer belt being sandwiched between the second transfer member and the opposed member,

wherein the opposed member is in contact with the second transfer member via the intermediate transfer belt.

13. The image forming apparatus according to claim 12, wherein the changing section changes the contact length by changing a position of the opposed member by moving the opposed member in a transfer direction of the recording medium.

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